USGS Technical Review of Report on "Supplemental Groundwater Tracing Summary Report, Arkwood, Inc., Superfund Site, Omaha, Arkansas, March 2015"

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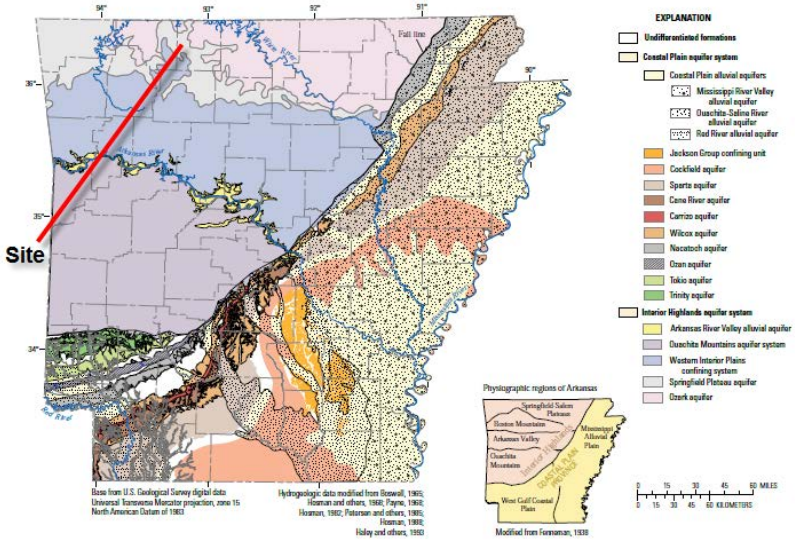

From USGS SIR 2014-4149.

Background on Arkwood Site

The US Geological Survey (USGS) Central Region under agreement with US Environmental Protection Agency (USEPA) Region 6 provides technical assistance to USEPA projects. As part of this agreement, a technical review was done by the USGS on the groundwater tracing efforts to define pathways from wells in the vicinity of an on-site sinkhole.

The Arkwood, Inc., site operated as a wood treating facility from 1962 to 1984 and is presently inactive. Pentachlorophenol (PCP) and dioxin-containing wastes were discharged to a sinkhole. The sinkhole was filled in the late 1990's.

The Arkwood, Inc. site is approximately one-half mile southwest of Omaha in north central Arkansas. The site consists of an approximately 18-acres parcel that slopes gently toward the northwest. It is located in a valley on Cricket Creek Road, bounded by ridges

covered with native trees. The site is generally sparsely vegetated and covered with gravel and rocks mixed with native, clayey soils. The site is in an area of karst geology that is characterized by subsurface fractures and channels. New Cricket Spring is located down valley immediately west of the site where water treatment operations occur from contaminated discharge from the site. In 2005, eleven shallow wells were installed near the sinkhole and ozone water injected into the formation. Non-ozonated water continues to be injected in the vicinity of the sinkhole as a means of flushing and facilitating the efficient operation of the treatment system at New Cricket Spring. The ozone injection system has reduced PCP concentrations in New Cricket Spring by more than 95 percent. However, the PCP values have reached an average of 50 micrograms per liter (ug/l) over the past five years and an average concentration below 20 ug/l over the past two years (Third Year Review, 2011).

From EPA (2011), Five year review report:

“A major conclusion from the Arkwood Remedial Investigation Report (April 4, 1990) concerning ground water was:

"It was determined that the site is underlain by a shallow, unconfined karst aquifer within the St. Joe Formation. Water movement appears to be dominated by conduit flow through fractures and other features that have been widened and enlarged by solution activity. A diffuse flow component of the aquifer appears to transport water from zones of storage within the deeper residuum clays and subcutaneous zone to the larger conduit network. The apparent lack of a well-defined water table complicates the determination of aquifer characteristics such as flow direction, gradient and velocity. The presence of shallow ground water is intermittent and depends on the precipitation. During periods of heavy rain, the subsurface fractures are saturated. The affected ground water emerging from New Cricket Spring provides evidence to indicate that this spring is hydraulically downgradient of the Arkwood site and that it is formed by the only major conduit to which affected ground water has been shown to be converging. Pentachlorophenol (PCP) levels detected in New Cricket Spring have been found to range from 1.0 to 2.3 mg/l.”

Also from the five year review:

“Based on the dye tracing studies, four springs were identified for monitoring: New Cricket Spring, Walnut Creek Spring, Cricket Creek Spring, and Railroad Tunnel Spring. As shown in Table 2 below, these springs were sampled quarterly from 1996 through 1999 except during periods of insufficient flow. In 2000, spring sampling was reduced to only New Cricket Spring, since this is the only spring that continued to be contaminated with PCP.”

The site is located within the Springfield-Plateau Aquifer (Kresse and others, 2014). The Springfield Plateau is characterized by the outcrop of the Mississippian-age Boone Formation, which comprises karsted limestone interbedded with chert. The Boone Formation constitutes the Springfield Plateau aquifer. The Springfield Plateau aquifer is separated from the underlying Ozark aquifer by the Chattanooga Shale, which is the primary unit of the Ozark confining unit. Locally, the Ozark confining unit is absent and the Springfield Plateau aquifer rests unconformably on rocks of the Ozark aquifer. Therefore, a key feature of the site is whether the underlying Chattanooga Shale is absent.

Boone County has a mean January temperature of 34.9, a mean July temperature of 79.1, and an average of 45.20 inches of precipitation each year. More snow falls each winter in this part of the state.

Purpose and Scope of Report

The work presented in the supplemental tracing study is part of on-going groundwater remediation activities at the site.

Important Findings from Report

Tracer injection tests using fluorescein and rhodamine dye were detected west of the site in New Cricket Spring and Cricket Pond discharge within short introduction (1 day) of the tracers. No tracer was detected laterally to the railroad ditches or to the east in adjacent watersheds.

General Comments

The maps and figures used to identify the site and important sampling locations are of poor quality and hard to follow. A better base with topographic contours would help map potential discharge locations. All receptors (other adjacent withdrawal wells) should be identified on maps.

I am unsure that the objectives of the tracer study were clearly identified. If the objective was to identify typical flow patterns than the introduction of 1,524 gallons, prior to tracer introduction, and 7,272 gallons, after tracer introduction for well A and the same for well B (see table) may create mounding effects and alter flow patterns. The table below shows

that injected water is equivalent to 22 in/yr for the period of the test or an amount probably similar to recharge from precipitation.

Injected well	Gallons injected (gal = .1337 ft3)	Effective recharge rate in inches over site (site area = 784,080 ft2)	Equivalent effective recharge rate in inches per year (multiply by ratio of min per year/min per test)
A	8,796	.0015	11
B	8,796	.0015	11
Total	17,592	.0030	22

Further water was pumped from a deep well. Therefore, when coupled with shallow mounding in the upper 30 feet, deep extraction could result in the enhancement of strong downward gradients that perhaps is not typically seen at the site. Is well 15 constantly pumped? Was this sampled during the test? Strong downward gradients would reduce lateral transport. The closest lateral transport pathways are the ditches.

Generation of water-level maps (water table and potentiometric) would help with identifying pathways. Ambient and injection maps would identify changes in flow patterns.

There is a valley to the south that could have been sampled to confirm additional pathways do not exist. The valley is about 0.7 mi to the south.

Less than 50% of the dye was recovered/detected at sample locations. While recovery rates from the injected dyes were not poor for this effort compared to other dye tests, assuming that an equivalent amount of dye or greater, was retained in non-mobile volume of the rock is speculative. Another scenario is that all pathways were not determined and some deep underflow occurs.

A better approach to assess mobile vs non-mobile porosity would be to perform injection-extraction tests where the extraction well is the primary sample location. Ambient tracer tests would help better define likely pathways typically encountered at the site for most of the time.

Specific Comments (not in order)

1. P.3. Sec. 1.1. The purpose and scope reads more like an approach. What is the objective to identify potential pathways?
2. P. 4. Sec. 1.3. Is there any preferred bedding direction in the rock? Label springs on map.

3. Figure 1. City water location #18 is missing on map. Poor quality figure, hard to read. Label springs.
4. Table 5. Label injection wells.
5. Table 6. How can well B be dry on 11/17/14 when water was injected into well for tests? Are these pre-test vales from 11/17/14? Why weren't contemporaneous water levels measured during test?
6. P. 13. Provide weir rating table.
7. Table 8. A runoff rate per area would be helpful to assess whether underflow is occurring at the weir.
8. Table 9-11. Including travel times in the table would be helpful.
9. Table 10-12. The sampling period is before the tracer introduction. Does this mean the concentration of the dye is a background value?
10. P.22. A key conclusion is that all pathways have been identified and therefore, the amount of dye recovered is a function of mobile and immobile porosity.
11. P.24. If the objective of the test was to identify paths from the sinkhole under ambient conditions then a less intrusive injection strategy should have been deployed.
12. P. 25. #6. A ratio of 20% to 80% mobile to non-mobile porosity means that the karst aquifer is 100 % made of voids over the whole site. What the authors likely mean is that some percentage of the 80% is made up of pores not readily accessible to transport.

References

Kresse, T.M., Hays, P.D., Merriman, K.R., Gillip, J.A., Fugitt, D.T., Spellman, J.L., Nottmeier, A.M., Westerman, D.A., Blackstock, J.M., and Battreal, J.L., 2014, Aquifers of Arkansas—Protection, management, and hydrologic and geochemical characteristics of groundwater resources in Arkansas: U.S. Geological Survey Scientific Investigations Report 2014–5149, 334 p., http://dx.doi.org/10.3133/sir20145149.

EPA, THIRD FIVE-YEAR REVIEW, Arkwood, Inc. Boone County, Arkansas, 2011.

Ozark Underground Laboratory, Inc., 2015, Supplemental Groundwater Tracing Summary Report, Arkwood, Inc., Superfund Site, Omaha, Arkansas, March 2015.